"Reply under 37 CFR 1.116
--Expedited Procedure--
Examining Group 2823

AF/2823

DOCKET NO. : MERCHANT 33-3-3 **PATENT**

23 Response 7/30 Fwded

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of::

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Sailesh Merchant, *et al.*

Serial No.: 09/092,158

Filed: June 5, 1998

For: METHOD FOR THE FABRICATION OF CONTACTS IN AN INTEGRATED CIRCUIT DEVICE

Grp./A.U.: 2823

Examiner: Maldonado, Julio J.

Honorable Commissioner of Patents
Washington, D.C. 20231

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231, on 6/19/2002 (Date)
Peggy Gray
(Printed or typed name of person signing the certificate)
(Signature of the person signing the certificate)

Sir:

AMENDMENT UNDER 37 C.F.R. § 1.116

In response to the Examiner's Action mailed April 19, 2002, please accept the following remarks.

REMARKS

In response to the Examiner's Action mailed April 19, 2002, the Applicants makes the forgoing remarks to place the Claims in condition for allowance, or alternatively, to frame the issues for appeal.

I. Rejection of Claims 1, 5-6, 8-12, 16-17 and 24 under 35 U.S.C. §103

The Examiner has rejected Claims 1, 5-6, 8-12, 16-17 and 24 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,591,671 to Kim *et al.* ("Kim") in view of U.S. Patent No. 5,714,418 to Bai *et al.* ("Bai"). The Examiner further rejected Claims 4 and 15 under 35 U.S.C. §103(a) as being unpatentable over Kim in view of Bai and further in view of the Applicant's admitted prior art. The Examiner also rejected Claims 7 and 18 under 35 U.S.C. §103(a) as being unpatentable over Kim in view of Bai and further in view U.S. Patent No. 5,970,374 to Teo ("Teo"). The Applicants respectfully maintain that the claimed invention is not obvious in view of the foregoing references, and that these references fail to establish a *prima facie* case of obviousness.

For example, as acknowledged by the Examiner, nothing in Kim suggests removing a substantial portion of the contact metal and the barrier layer from the semiconductor substrate to form a contact plug within the contact opening, the plug extending to an uppermost surface of the substrate, as recited in Claim 1. Furthermore, Kim also fails to suggest subjecting the contact plug to a temperature sufficient to anneal the barrier layer, also recited in Claim 1.

As noted in a telephone conversation with the Examiner on June 13, 2002, Kim states that heat treatment is performed *after* forming the refractory metal 28 on barrier layer 27. (Column 5, Lines 15-16). Kim does this so that oxidation of the barrier layer and ohmic contact layer can be prevented, thereby preventing the deterioration of the contacting resistance property. (Column 5, Lines 17-18). Alternatively, if the refractory metal is formed from a material which is easily oxidized, an insulating layer is formed on the whole surface of the resultant structure (Column 5, Lines 31-36). Again, the reason for the insulating layer is to prevent oxidation of the barrier layer and the ohmic contact layer, as well as the metal. (Column 5, Lines 32-39). In certain embodiments,

Kim performs an etch back so as to accommodate an oxidation prevention cap layer 34. (FIGURE 4C and Column 5, Lines 62-66). It follows, therefore, that the above cited elements of Claim 1 are contrary to Kim's method because, for example, removing a substantial portion of Kim's metal and barrier layers to form a contact plug would leave remaining portions of the barrier layer exposed to oxidation. Rather, Kim requires that the metal layer remain on the barrier layer, so as to prevent oxidation of the barrier layer. Alternatively, in embodiments where the metal is oxidizable, Kim applies an insulating / oxidation prevention cap layer, and therefore the contact plug is no longer extending to an uppermost surface of the substrate. And, in either event, the plug does not extend to the uppermost surface of the substrate, as recited in Claim 1 and the other independent Claims 12 and 24.

The Examiner cited Bai (Column 9, Lines 12-25) for the proposition of teaching the steps of removing a substantial portion of a contact metal 44 and barrier layer 42, 43 from a substrate 40, 41 to form a contact plug within a contact opening 47, the plug extending to the uppermost surface of the substrate 40, 41. The Applicants respectfully take issue with the Examiner's §103 rejection. As explained below, Kim and Bai fail to teach or suggest all elements of the claimed inventions and thus fail to establish a *prima facie* case of obviousness. Additionally, the asserted combination of Kim with Bai fails to establish a *prima facie* case of obviousness because the combination of these two references is improper.

As further noted in the telephone conversation with the Examiner, Bai fails to cure the deficit teachings of Kim. For example, after forming capture layer 43 and blocking layer 42, but before depositing copper, Bai subjects these barrier layers to a high temperature anneal. (Column 8, Lines 58-64). Bai does this to anneal micro defects in the barrier layers so that the barrier layers can more

effectively prevent diffusion of Copper atoms into the device (Column 8, Lines 63-65; Column 3, Lines 56-66). Performing a thermal annealing step *after* the deposition of metal, as done by Kim, would therefore be contrary to Bai's goal of annealing micro defect in the barrier *before* depositing metal on the barrier. Later, Bai performs CMP to remove the copper layer 44, blocking layer 42 and capturing layer 43 from the upper surface of the dielectric. But there is no suggestion of perfoming a thermal anneal after the CMP step. Therefore Bai fails to suggest subjecting the contact plug to a temperature sufficient to anneal the barrier layer, as recited in Claim 1.

Moreover, the asserted combination of Kim with Bai fails to establish a prima facie case of obviousness because the combination of these two references is improper. The combination of Kim with Bai is improper because a person having ordinary skill in the art would not be motivated to find or add to Kim the teachings and suggestions of Bai, inasmuch as Bai does not address the problem of preventing oxidation of Kim's barrier and ohmic contact layers, which Kim addresses by depositing a refractory metal layer over the barrier and ohmic contact layers prior to heat treatment. In contrast, Bai is not concerned with the oxidation of his capturing and blocking layer. Rather, Bai wishes to curing micro defects in his barrier so that Copper atoms will not diffuse through the barrier. It follows, therefore, that there would be no motive to insert Bai's step of annealing the barrier layers prior to depositing the metal because this step would run contrary to Kim's goal of preventing oxidation of the barrier layer and ohmic contact layer. In fact such as step would destroy the functionality of Kim's device, because this would allow oxidation of the barrier layer and ohmic contact layer.

Teo also fails to cure the deficit teachings of Kim or Bai. The Examiner cites Teo merely for the proposition of teaching rapid thermal annealing. Teo, however, performs thermal annealing

after the deposition of a Ti layer 16 and a TiW layer 18 (Column 4, Lines 17-25; FIG. 3A), but *before* the deposition of tungsten 40. (Column 5, Lines 3-8; FIG. 3E) Thus, Teo's process falls within the scope of Prior Art depicted in FIGUREs 1A and 1B where rapid thermal annealing is performed before plug formation. (*See e.g.*, Application Page 4, Lines 18-33). Therefore Teo fails to suggests subjecting the contact plug to a temperature sufficient to anneal the barrier layer, as recited in Claim 1. Moreover, for the same reasons discussed for combination of Kim and Bai, Teo's teaching of annealing prior to the deposit of a metal layer, is contrary to Kim's goal of preventing the oxidation of the barrier layers, and therefore combination of Kim and Teo is improper.

Finally, as noted to the Examiner in the telephone conversation, the interrelationship of the process steps set forth in Claims 1, 12 and 24 is inherent in the language of the Claims.

In summary, the combined teachings of Kim with Bai or Teo do not teach or suggest all elements of the present invention and therefore fail to establish a *prima facie* case of obviousness with respect to independent Claim 1, as well as independent Claims 12 and 24, which contain analogous elements as in Claim 1. Moreover the combination of Kim with Bai, or Kim with Teo are improper. In view of the foregoing remarks, the cited references also do not support the Examiner's rejection of dependent Claims 4, 8-10, 15, 19-21, and 23 under 35 U.S.C. §103(a). The Applicants therefore respectfully request the Examiner withdraw the rejection and allow these Claims.

III. Conclusion

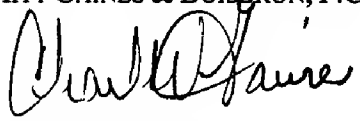
In view of the foregoing remarks, the Applicants now see all of the Claims currently pending in this application to be in condition for allowance and therefore earnestly solicit a Notice of Allowance for Claims 1, 4-12 and 15-24.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Version with markings to show changes made.**"

The Applicants request the Examiner to telephone the undersigned attorney of record at (972) 480-8800 if such would further or expedite the prosecution of the present application.

Respectfully submitted,

HITT GAINES & BOISBRUN, P.C.



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